10.0 IDENTIFICATION AND ANALYSIS OF CLOSURE ALTERNATIVES

The selection of the appropriate closure alternative for the entire Morning Star Mine site will depend on the:

- Type of waste material to be disposed of;
- Concentration of cyanide, metals and other contaminants in the waste materials;
- Volume of waste materials; and
- Effectiveness, implementability, and cost of each option.

The alternatives analyzed for this document focus on the closure of the two heap leach pads and the PSP. Other portions of the mine site may be addressed in subsequent documents. As part of the effort to fill data gaps identified during production of the draft EE/CA, Harding ESE was requested to evaluate the potential to backfill the pit. Pit backfill is discussed in Alternative 3a.

During the evaluation process, the closure alternatives are screened to insure that adequate engineering and cost details are developed for each alternative to provide for detailed analysis. Alternatives analyzed in detail include the No Action alternative, Closure of the Heap Leach Pads in Place (low permeability capping with the potential for final treatment and disposal of draindown water in a bioremediation cell), Clean Closure of the Heap Leach Pads in Place (with an option to create a repository in the open pit), and Off-site Removal – Landfill or Aggregate Re-Use. In addition, the Mineral, Metal & Mining Management Company (4EM, 2001) has submitted a remediation work plan to the NPS. The 4EM work plan is described in this document using information provided by the applicant.

The primary objective of closure of the Morning Star site is to protect human health and the environment in accordance with guidance provided by the ARARs. Specifically, the selected closure alternative must limit human and ecological exposures of the identified process-related contaminants and reduce the mobility of those contaminants through direct contact with groundwater and surface water exposure pathways. Because compliance orders from the LRWQCB are in place due to the release of cyanide to the environment, each of the alternatives includes the cost for water management (Table 5). Implementation of the Interim Measures in 2002 (total cost $267,563) reduced the solution levels within containment, repaired the existing

damage from erosion, and put in place a re-circulation system that can be expanded for water management of the selected alternative.

The Engineering Evaluation and Cost Analysis (EE/CA) prepared for the Morning Star Mine follows guidance provided by EPA for a streamlined risk assessment (EPA, 1993). As a result, alternatives considered in detail were limited in number by an initial screening process that evaluated the effectiveness, implementability, and cost of each option that provided the reduction in environmental and human health risk as required by the ARARs. In addition, the EE/CA examined remediation of only three mine site features, the two heap leach pads and the PSP. Pad No. 2 has been discharging solution to the environment for at least three years and there is concern regarding the potentially catastrophic loss of containment from the other two structures. Due to the presence of cyanide and metals in the solution and the need to protect human health and the environment, the EE/CA was focused on these structures to implement a remedy as quickly as possible.

The Interim Measures were implemented and will continue to be operated regardless of which closure alternative is recommended as the preferred alternative. Closure alternatives were developed to reduce or eliminate the potential short-term and long-term impacts to surface and groundwater. The Interim Measures were designed to significantly reduce the likelihood of loss of solution by overtopping of the liners at the heap leach pads and PSP, and by remedial action taken on erosion features in berms.

Following implementation of the Interim Measures, closure options brought forward as alternatives include:

Alternative 1. No Action. Implementation of the Interim Measures for 30 years. No additional remediation of site facilities.

Alternative 2. Closure of the Heap Leach Pads in Place. Draw down and evaporate the solution inventory in the two heap leach pads followed by installation of a low permeability capping system designed to minimize the addition of meteoric water to the system and reduce the hazard of slope failure. The caps would be vegetated. Following completion of evaporation and

final treatment of solution as necessary, the PSP liner would be removed and hauled to an approved landfill and the PSP disturbance footprint would be reclaimed.

Alternative 3. **Clean Closure of the Heap Leach Pads in Place**. This alternative includes the use of active evaporation and bioremediation systems to treat and dispose of process solution in the heap leach pads. A bioremediation treatment system would be applied to the pads to reduce cyanide levels, immobilize soluble metals and treat the water to regulatory compliance levels. The pads would be regraded and a low permeability capping system installed to minimize the addition of meteoric water to the system and reduce the hazard of slope failure. Following completion of evaporation and final, post-capping treatment of solution as necessary, the PSP liner would be removed and hauled to an approved landfill and the PSP disturbance footprint would be reclaimed.

Alternative 3a. Clean Closure of Heap Leach Pads, Haul Material to Pit Repository. This alternative includes the use of active evaporation and bioremediation systems to treat and dispose of process solution in the heap leach pads. A bioremediation treatment system would be applied to the pads to reduce cyanide levels, immobilize soluble metals and treat the water to regulatory compliance levels. Once discharge compliance levels have been achieved, pad material would be hauled to the pit for disposal. The pit floor would be prepared by placement of waste rock to a minimum of 10 feet above the water elevation in the pit. As pad material is placed in the pit, a second bioremediation treatment would be applied to continue the reduction of cyanide levels and immobilization of soluble metals When completed, the pad material would be shaped and a low permeability cap system installed to minimize the addition of meteoric water. Positive drainage off the cap and a perimeter drain around the pit would be created and the cap would be revegetated. The existing heap leach pad liners would be hauled to an approved disposal facility and the pad footprint areas would be reclaimed. The PSP liner would also be hauled to an approved disposal facility and the footprint of the PSP reclaimed.

Alternative 4. Off-site Removal (Landfill or Aggregate Re-Use). This alternative includes the use of maximized enhanced evaporation methods to dispose of and bioremediation methods to treat process solution in the heap leach pads and PSP. Once target solution volumes and solution quality have been achieved the heap leach material would be loaded and hauled for disposal in an approved landfill. The pad liners from the heap leach pads and PSP would also be removed and

hauled to an approved landfill for permanent disposal and the disturbance footprints reclaimed and revegetated.

An option to Alternative 4 would be to use the heap leach pad material for an off-site beneficial material, such as a source of crushed aggregate. Evaporation and bioremediation would be required to achieve discharge compliance levels. Once solution quality improvement and volume reduction was achieved, the heap leach material would be loaded and hauled for off-site beneficial use, such as roadbed material. The pad liners from the heap leach pads and PSP would be removed and hauled to an approved landfill for permanent disposal and the disturbance footprints reclaimed and revegetated.

Alternative 5. Off-Site Removal (4EM Work Plan) This alternative would remove approximately 2,000,000 tons of heap leach material for beneficial reuse as pozzlan, a concrete additive. Enhanced evaporation methods would be utilized to dispose of process solution in the heap leach pads and PSP before the startup of the operation. Once solution volume reduction was achieved, the heap leach material would be crushed, loaded and hauled for use as a beneficial concrete additive.

The heap leach material would be excavated from the heap leach pads into a hopper and moved to a ball mill using a covered conveyor belt system. The pad material would be crushed to a fine powder (less than 325 mesh) and stored in a silo prior to transport in pneumatic trailers as a finished product.

Both Alternatives 4 and 5, because of significant increases in truck traffic, will require tortoise fencing. It is anticipated that concern for increased tortoise mortalities will require a mitigation plan to be developed and that installation of temporary fencing would be one of the mitigation stipulations.

10.1 Alternative 1 – No Action

Future activities, including closure activities and monitoring beyond the continuation of the Interim Measures, would not be conducted at the site under the No Action alternative. The

operation and maintenance of the Interim Measure would be continued into perpetuity (30 years). Activities initiated during the Interim Measures such as access control, monitoring of solution levels and maintenance of evaporation will continue. No capping, repair of liners, contouring, re-vegetation or other remediation and reclamation measures will be taken.

10.1.1 Overall Protection of Human Health and the Environment

This alternative was developed as a temporary measure and not designed to insure long-term protection of human health and the environment.

10.1.2 Compliance with ARARs

This alternative was developed as a temporary measure and as such, not intended to withstand rigorous compliance with ARARs.

10.1.3 Long-term Effectiveness and Permanence

No controls or long-term measures other than continued operation of the Interim Measures would be constructed on the site; consequently, all current and future risks would remain the same. Therefore, the No Action alternative would not be effective at minimizing the long-term risks from exposure to site materials.

10.1.4 Reduction of Toxicity, Mobility or Volume through Treatment

The No Action alternative would provide no reduction of toxicity, mobility or volume of the solution inventory beyond the implementation of the Interim Measures. A portion of the solution inventory would be affected by evaporation; however, meteoric water would continue to be added to the system.

10.1.5 Short-term Effectiveness

In the short-term, the No Action alternative would pose no additional threats to the community or the environment under the current site conditions and implementation of the Interim Measures. The time required until discharge limits are met through natural degradation of the cyanide in the solution would be indefinite. In the meantime, the risk from catastrophic slope failure and subsequent loss of solution containment would continue to increase.

10.1.6 Implementability

The only requirement of the No Action alternative would be continued monitoring and inspections following implementation of the Interim Measures. The Interim Measures are both technically and administratively feasible within local, state and federal guidelines and could be implemented immediately. The Interim Measures have been designed within the limitations posed by the current site conditions: lack of electric power, limited availability of maintenance personnel for on-site operations and maintenance, remoteness of the site, and local climatic extremes.

10.1.7 Costs

Costs to implement the No Action alternative involve a continuation of the site inspections and maintenance initiated with the Interim Measures, with costs added to include potential contingencies, such as emergency repairs.

The total present worth cost for the No Action Alternative has been estimated at $505,754. Costs to implement the No Action Alternative are presented in Table 10.1 (Tables Section of Appendices). The total cost includes the present worth value of 30 years of inspections and maintenance at the site and has been adjusted to account for current cost of the money.

10.2 Alternative 2 – Close Heap Leach Pads in Place

Closure of the heap leach pads in place (Fig. 7) would involve reduction of the solution inventory, shaping of heap leach pad material and capping with a low permeability cap system designed to minimize infiltration. Approximately 200,000 cubic yards of pad material would be hauled from Pad No.1 to Pad No.2 to establish 3:1 slopes, repair damage from erosion and shape the pads to blend visually into the surrounding topography.

While Pad No.1 would be capped immediately, solution reduction through evaporation would have to be aggressively pursued at Pad No.2 until the solution is reduced to a volume that can be contained in the PSP. Once both pads are shaped and capped, limiting meteoric inflow, a minor volume of draindown from the pads to the PSP would continue for an unknown period of time. The PSP can be used to evaporate a steady inflow of 3.5 to 4 gallons of water per minute, which is the estimated average outflow from the pads.

The low permeability caps will consist of a number of components designed to reduce the infiltration of precipitation into the pads and the hazard of future slope failure. Initial cap component design will include shaping and compacting the surface of the crushed ore on the heap leach pads to blend visually with the local topography. The surface of this layer would be prepared to avoid punctures of the low permeability liner by large rocks or surface debris. The low permeability liner will be either a flexible membrane liner such as HDPE or a fabricated geosynthetic clay liner (GCL). This liner will be covered with a surface water collection and drainage layer designed to move meteoric water off the surface of the pad (Fig. 7). Meteoric water will be directed away from the surface of the pads into the naturally occurring ephemeral drainages on either side of the heap leach pads. The final component of the low permeability liner will be one foot of cover composed of growth media obtained from the vicinity of the mine site. The cover will be vegetated with a seed mixture approved by the MNP.

The PSP will remain as a component of the solution evaporation system until all practical volumes of solution have been removed from the pads. Any residual draindown from the pads will continue to be collected in the PSP where it will be evaporated. Once all practical volumes of solution have been actively removed from the pads, meteoric data indicates that the remaining volume of pad draindown can be evaporated from the PSP. Approximately 3 gallons per minute (gpm) is anticipated as the long-term draindown from Pad No.2 and approximately 2 gpm from Pad No.1. Initially (after evaporative measures and capping), inflow to the PSP will be regulated to avoid overtopping; however, as drawdown occurs and flow rates decrease, the remaining solution can continue to be drained until evaporation is complete.

Because of remaining unknowns, costs have not been developed for the following tasks:

- Drilling and sampling the pads for designation as Class D wastes;
- Additional chemical analysis of leachate and solids within the pads;
- Permeability testing, design and materials selection for land application infiltration areas;
- The determination of allowable concentrations of TDS or non-toxic species within the vadose zone materials;
- Preparation of permit applications; and
- Long term monitoring costs.

10.2.1 Overall Protection of Human Health and the Environment

Closure in place would provide for protection of human health and the environment because of the reduction in risk due to loss of solution containment. As the solution inventory is reduced through evaporation, the ability of the containment on site to prevent solution loss is enhanced for the short-term. As the closure in place alternative components are put in place, the temporary risk reductions become long-term risk reductions as the low permeability caps are put in place. As these systems are completed, the volume of the solution in inventory is significantly reduced. The risk from intense, brief duration precipitation events is reduced as a source to increase the volume of solution in containment.

10.2.2 Compliance with ARARs

Removal actions pursuant to CERCLA are required to attain compliance with ARARs under Federal and state environmental laws to the extent practicable considering the urgency of the situation and the scope of the removal (EPA, 1993). The project area is in the Ivanpah Desert Wildlife Management Area of the Eastern Mojave Recovery Unit as described by the Desert Tortoise Recovery Plan developed by the U.S. Fish and Wildlife Service (FWS, 1994). Location-specific ARARs may cause scheduling delays due to measures that may be required for protection of listed species. For example, worker awareness training and regular site and road patrols may be initiated to prevent harm to desert tortoises that may obstruct roadways (Desert Tortoise Council, 1999). It is anticipated that the mitigation measures developed for construction activities and truck traffic associated with the closure of the pads in place alternative will include the installation of temporary tortoise fencing, worker and driver education and safety precautions for haul trucks. All physical contact with tortoises is restricted to authorized biologists. It is anticipated that a notification and abatement procedure would be required to physically remove individual tortoises from the work area or transportation route.

10.2.3 Long-term Effectiveness and Permanence

Closure in place, comprised of reducing solution volumes in the pads and installation of low permeability caps, will provide an effective and long-term reduction in risk to human health and the environment. The integrity of the low permeability caps would need to be maintained to ensure that the covers continue to perform as designed; therefore, long-term monitoring, inspection, and maintenance would be required. It is anticipated that growth of the vegetation on the portions of the site which have been graded and amended with cover soil would require many

years to approach pre-mining conditions. However, the slope reductions conducted as part of the cap installation will provide for significant minimization of the potential for large-scale erosional features to develop on the reclaimed mine features.

10.2.4 Reduction of Toxicity, Mobility or Volume through Treatment

It is anticipated that the volume of solution would be reduced through drain down and subsequent evaporation in the PSP. According to sample analyses, the presence of cyanide in the solution is the primary analyte of concern in the WDRs. Once the volume of solution is reduced, and the continued addition of meteoric water significantly diminished by the low permeability caps, this alternative would be an effective option. A final polishing of drain down water may be required if run-on/runoff on the pads cannot be disposed of through enhanced evaporation. This final treatment would include the creation of a bioremediation treatment cell in the PSP with subsequent discharge of water that meets discharge limits to a drainfield.

10.2.5 Short-term Effectiveness

The application of the Interim Measure would greatly reduce the risk to human health and the environment from the potential loss of solution. It is anticipated that the construction phase of this alternative would be accomplished within one field season; therefore impacts associated with construction would likely be short-term and minimal. Efforts to reduce short-term impacts will be initiated during the construction phase. Park ecologists will be consulted to develop plans for implementation of the alternative while providing maximum protection to park resources (Desert Tortoise Council, 1999). On-site workers would be adequately protected by compliance with industry-standard personal protective equipment and following proper operating and safety procedures. Short-term impacts to air quality in the surrounding environment may occur due to the relatively brief impact of construction equipment on dry, non-cohesive surface soils, as well as the sandy surface condition of the unpaved access road to the site. The application of water or a dust suppressant as needed would provide control of fugitive dust emissions to sites receiving heavy vehicular traffic or in construction areas.

Solution inventory reduction by evaporation will break down a portion of the cyanide by oxidation. The off gassing of cyanide is not anticipated to pose any risk to human health or the environment. Construction of a reduced permeability cap will prevent or significantly reduce the

availability of cyanide to groundwater because of the limited availability of meteoric precipitation to the contents of the pads.

Installation of low permeability caps will significantly reduce the potential increase in solution volume due to the addition of meteoric water into the heap leach pad and PSP. This benefit of capping the pads will not only increase the likelihood that solution containment can be maintained, but will reduce the threat of catastrophic loss of containment by slope erosion or liner failure. Even in extremely arid conditions there is a potential for brief, sudden rainstorms. The low permeability cap will include a drainage and capillary break layer that will move run-on/runoff effectively off the cap.

10.2.6 Implementability

Regrading and capping the pads and regrading the PSP would be technically and administratively feasible. These activities are routinely engineered and performed as tasks that are part of mining, industrial and municipal operations. Although the MSM site is remote, services and materials that would be required by this alternative are readily available through contractors and vendors in the region.

10.2.7 Costs

Costs to complete the Closure of the Heap Leach Pads in Place Alternative include implementation of the Interim Measures, installation of temporary tortoise fencing, solution inventory reduction, shaping the heap leach pads, placement of a low permeability cap on the heap leach pads, and site revegetation. Preliminary costs were developed to install a bioremediation cell in the pregnant PSP should a final polishing step be necessary to achieve discharge standards. Rough calculations of costs for sampling and monitoring have been included in the cost estimate.

The total present worth cost for the Closure of the Heap Leach Pads in Place Alternative has been estimated at $2,625,956. Costs to implement closure of the heap leach pads in place are presented in Table 10.2 (Tables Section of Appendices).

10.3 Alternative 3 - Clean Close Heap Leach Pads in Place

Clean closure of the heap leach pads in place (Fig. 8) would require rinsing the contents of the heap leach pads with water until federal and state discharge criteria can be met. The number of pore volumes required to achieve clean closure is typically determined by a series of column tests run under laboratory conditions in which columns are charged with pad material and rinsed with fresh water. The effluent is analyzed for the presence of metals and cyanide and the number of pore volumes of rinsing is calculated to achieve the desired results. No column test results are available for use in evaluating the clean closure alternative; hence it is not known how many pore volumes of rinse water would be required to achieve the required discharge criteria level. It may be desirable to conduct column tests to determine specifics regarding the rinsing protocol. A bioremediation treatment system would be added to the rinse water to facilitate reduction of cyanide and other constituents of concern in the heap leach pads.

Available rinse water would be pumped from the open pit or on-site wells and applied to the surface of the pads via drip or conventional agricultural-type irrigation methods. When the mine was in operation, Vanderbilt pumped groundwater from a site lower in the valley and piped the water through a buried pipeline to the mine site. Specific information regarding the source, volume and ownership of this groundwater resource is not known at this time, and therefore, the availability of the valley groundwater as a source of rinse water has been considered uncertain for this evaluation.

With this alternative, soluble metals in the pads would be immobilized in place and the water in inventory treated to regulatory compliance levels. In situ immobilization is a process in which a solution containing sugars, phosphate, alcohol, proteins and fats is selected to optimize immobilization of metals through bacterial reduction of oxygenated species electrochemically using biogenic hydride. The technology involves a gaseous sweep with biologically generated CO2 and other gases at depth, with a surficial treatment to stabilize soluble lead in the upper portions of the heaps. This process has been used successfully at other mine sites using less than 0.1 pore volume of rinse water to achieve target stabilization levels. The objective of in-situ immobilization is to biochemically treat fluid and solid materials within the leach pads to target compliance levels. Achievement of compliance levels would enable the pads to be reclassified as

Class D equivalent waste (detoxified). It is estimated that approximately 1.996 million tons of materials in place on the pads and four million gallons of leach solution would be treated.

As water, treated to compliance levels, drains down from the pad it would be piped to the PSP. Additional sugars and alcohol would be blended into the solution. The attenuation capacity of the leachate would be enhanced during this phase of the process. A final disposal area for leachate treated to discharge limits would be created by the construction of a drainfield downgradient of the PSP. The enhancement of using added nutrients would create sulfate-reducing conditions at depth in the drainfield/infiltration area, eliminating the risk to waters of the state. The leachate would gravity drain into the drainfield/infiltration area from the PSP.

It is proposed that a 90-day field trial be initiated by using a small volume of solution from the PSP. The target concentration of nutrients would be applied to an area specified as a land application infiltration area and the site monitored with a series of shallow lysimeters. It is anticipated that the field trial will substantiate the effective treatment of soluble species such as cyanide, nitrate, sulfate, and metals. Once agency concurrence has been granted, drain down from the pad can be directly plumbed to the infiltration area, maintaining the use of the PSP for contingency storage and disposal measures as needed.

Once state and federal discharge criteria have been met, a reduced permeability-type cap to limit infiltration and reduce the potential hazard of slope failure will be constructed on the heap leach pads. The cap will consist of a number of elements designed to reduce infiltration of precipitation into the pads. Initial cap component design would include shaping and compacting the surface of the crushed ore on the heap leach pads as needed. Approximately 200,000 yards of material from Pad No.1 would be hauled to Pad No.2 in order to achieve 3:1 slopes and repair damage from erosion. The surface of this layer will be prepared to avoid punctures of the low permeability layer by large rocks or surface debris. The low permeability liner will be either a flexible membrane liner such as HDPE or a fabricated GCL liner. This liner will be covered with a two-foot drainage and capillary break layer designed to move meteoric water off the surface of the pad. Meteoric water will be directed away from the surface of the pads into the ephemeral drainages present on either side of the heap leach pads. The final layer of the cap will be one foot of growth media composed of soil obtained from the vicinity of the mine site. The cover will be vegetated.

The second option (Alternative 3a) for closure of the heap leach pads is to load, haul and place the rinsed pad material in the open pit for disposal. Available water from the pit would be used for rinse water on the pads as well as dust control on the roads. The pit would be prepared for use as a repository by hauling and placing waste rock to a minimum of 10 feet above the measured static water level in the pit. The pad material would then be excavated, hauled and compacted evenly over the new pit floor. As the pad material was placed in the pit, it would be treated a second time with bioremediation additives to continue to neutralize cyanide and nitrates and immobilize metals. A low permeability cap consisting of either an HDPE membrane or GCL liner, 24 inches of drainage/capillary break material, and 12 inches of growth media would be constructed over the treated pad material, and the cap revegetated. The elevation of the cap would be engineered to create a free-draining surface within the pit and perimeter run-on/runoff control would be established.

10.3.1 Overall Protection of Human Health and the Environment

The implementation of this alternative and/or the alternative option would provide a means of reducing the threat of exposure to cyanide by lowering its concentration in the solution to compliance levels. The volume of solution will be reduced through evaporation, treatment, or final polishing in a bioremediation cell and injection into a drain field. As the level of solution contained on the pads and in the PSP is lowered, so is the likelihood of loss of solution to the environment through overtopping liner containment. Regrading the slopes on the pads in preparation for the placement of the low permeability cap will provide erosion protection. Once the liner is in place, the infiltration of precipitation, which would increase the volume of solution in inventory, would be decreased.

Similarly, the treatment of pad materials in place, followed by hauling and secondary treatment in the pit repository would reduce the threat of exposure to cyanide by lowering its concentration in the solution to compliance levels. The construction of a low permeability cap and perimeter drain on the pit repository would reduce the likelihood of infiltration of precipitation into pad materials placed in the pit.

Reduction of cyanide concentration levels would reduce the threat of direct human exposure through ingestion or dermal contact to solution. Environmental and ecological exposures would also be reduced over the long-term.

10.3.2 Compliance with ARARs

The site components examined by this document would include the material on the heap leach pads associated with the beneficiation of ore, and the disposal of any long-term, though minimal drainage, from the capped pads. Other potential problems with filling in the pit include possible designation as waters of the state of California by LRWQCB, possible wetland designation by COE/EPA, and ownership of unpatented claims by claimants other than Vanderbilt. The volume of the rinse water required by the clean closure of the heap leach pads in place alternative would be added to the solution inventory that would have to be evaporated, or treated and discharged after final polishing to a drainfield, land application area or infiltration gallery. Reclassification of the treated pads as Class C equivalent waste (detoxified) and treatment of solution to required discharge criteria may result in this alternative and alternative option complying with ARARs.

The project area is in the Ivanpah Desert Wildlife Management Area of the Eastern Mojave Recovery Unit as described by the Desert Tortoise Recovery Plan developed by the U.S. Fish and Wildlife Service (FWS, 1994). Location-specific ARARs may cause scheduling delays due to measures that may be required for protection of listed species. For example, worker awareness training and regular site and road patrols may be initiated to prevent harm to desert tortoises that may obstruct roadways (Desert Tortoise Council, 1999). It is anticipated that the mitigation measures developed for construction activities and truck traffic associated with the clean closure in place alternative will include the installation of temporary tortoise fencing (potentially including fencing the pit under Alternative 3a), worker and driver education and safety precautions for haul trucks. All physical contact with tortoises is restricted to authorized biologists. It is anticipated that a notification and abatement procedure would be required to physically remove individual tortoises from the work area or transportation route.

10.3.3 Long-term Effectiveness and Permanence

Clean closure, comprised of rinsing the pads and installation of a low permeability cap, will provide an effective and long-term reduction in risk to human health and the environment. The integrity of the low permeability liner would need to be maintained to ensure that the cover

continues to perform as designed; therefore, long-term monitoring, inspection, and maintenance would be required. It is anticipated that growth of the vegetation on the graded and topsoiled portions of the site would require many years to approach pre-disturbance levels.

10.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The objective of this alternative is to provide a reduction in solution contaminant levels and to immobilize metals and treat cyanide and nitrates in place prior to constructing a low permeability cap on the heap leach pads. The implementation of treatment and rinsing will reduce the solution contaminants to acceptable levels. Typically in rinsed heap leach pads, a small volume of potentially contaminated materials may remain in the heap leach pads in isolated areas not saturated by rinse water. The introduction of bioremediation treatment measures during the rinsing process will provide for additional reduction in the mobility of metals and the toxicity of other solution components. Subsequent capping and closure of the pads will significantly reduce the risk to human health or the environment of any remaining potentially contaminated material.

Similarly, the treatment of pad materials in place, followed by hauling and secondary treatment in the pit repository (Alternative 3a) would reduce the threat of exposure to toxic elements in the pad materials and solution by treating the solution to compliance levels. The construction of a low permeability cap and perimeter drain on the pit repository would reduce the likelihood of infiltration of precipitation into pad materials placed in the pit, maintaining the decreased moisture level in treated pad materials.

10.3.5 Short-term Effectiveness

The application of the Interim Measure would greatly reduce the risk to human health and the environment from the potential loss of solution. It is anticipated that rinsing operations and bioremediation treatments to reduce the solution concentrations to desired levels, followed by draindown and evaporation of the solution inventory would require two years. A low permeability cap to reduce meteoric inflow could be constructed in one field season after solution volumes have been reduced; therefore impacts associated with construction would likely be short-term and minimal. Similar timeframes for treatment, solution reduction and construction would apply to Alternative 3a as well.

Efforts to reduce short-term impacts will be initiated during the construction phase. Park ecologists will be consulted to develop plans for implementation of the alternative while providing maximum protection to park resources. On-site workers would be adequately protected by using industry-standard personal protective equipment and by following proper operating and safety procedures. Short-term impacts to air quality in the surrounding environment may occur due to the impact of construction equipment on dry, non-cohesive surface soils, as well as the sandy surface condition of the unpaved access road to the site. The application of water or a dust suppressant as needed would provide control of fugitive dust emissions to sites receiving heavy vehicular traffic or in construction areas.

Installation of a low permeability cap will significantly reduce the increase in solution volume due to the addition of meteoric water into the heap leach pad and PSP system. This benefit of capping the pads will not only increase the likelihood that solution containment can be maintained, but will reduce the threat of catastrophic loss of containment by slope erosion or liner failure. Rinsing and treatment through bioremediation methods will reduce the toxicity of solution components and immobilize metals in place. Even though the level of cyanide in the solution in the pads will be reduced by implementation of this alternative, it will still be necessary to maintain the effectiveness of the caps in both the short and long-term by ensuring slopes have been adequately reduced to inhibit erosion.

Comparable precautionary measures would be required by selection of Alternative 3a. Rinsing and treatment through bioremediation methods will reduce the toxicity of solution components and immobilize metals in the heap leach pads in place. Creating a repository in the pit of detoxified pad materials will still require the long-term protection of a low permeability cap to reduce infiltration, protect groundwater and minimize the potential for erosion.

10.3.6 Implementability

Technology is available to bioremediate the pad materials and the process solution to detoxify the pads and the solution inventory. Regrading and capping the pads with a low permeability cap and reclamation of the PSP would be technically and administratively feasible. These activities are routinely engineered and performed as tasks that are part of mining, industrial and municipal operations. Although the MSM site is remote, services and materials that would be required by this alternative are readily available through contractors and vendors in the region.

10.3.7 Costs

Costs to implement the Clean Closure of Heap Leach Pads in Place Alternative (Alternative 3) include implementation of the Interim Measures, installation of temporary tortoise fencing, rinsing and bioremediation of pad materials and the process solution to detoxify pad materials and solution concentrations, solution inventory reduction, shaping of the heap leach pads, placement of a low permeability cap on the heap leach pads, reclamation of the PSP and site revegetation.

The total present worth cost for the Clean Closure of Heap Leach Pads in Place Alternative has been estimated at $2,914,809. This estimate is based on readily available, on site water to use as a rinsate. In the event that water supplies are depleted prior to completion of rinsing, water will have to be imported or pumped from the valley floor, driving up associated costs. Costs to implement the clean closure of the heap leach pads in place are presented in Table 10.3 (Tables Section of Appendices).

Costs to implement the option of hauling the rinsed pad material to the pit (Alternative 3a) have been estimated at $4,977,694. The activities in the cost estimate include rinsing and treatment of pad materials and solution, evaporation of the solution inventory, hauling and placing waste rock in the pit to create the repository, secondary treatment of pad materials during placement in the pit, construction of a low permeability cap on the pad materials, reclamation of the heap footprints and PSP and revegetation of the pad and pit areas. Costs to implement the clean closure haul option are presented in Table 10.3a (Tables Section of Appendices).

Costs for Alternatives 2, 3 and 4 as presented in Tables 10.2, 10.3 and 10.4 include the cost to design and install passive evaporation systems on Pad No.2. Costs to design and install active evaporation systems, consisting of irrigation type drips and sprays, are detailed in Table 10.5. These costs would total $321,779. Utilization of an active evaporation system would reduce the risk of significant addition of meteoric water to the pads' solution inventory because of the reduction in elapsed time to evaporate the solution.

10. 4 Alternative 4 – Off-site Removal - Landfill or Aggregate Re-Use

Off site removal (Fig. 5) would involve excavation of approximately 2,000,000 tons of heap leach pad material and liners and removal to a licensed solid waste disposal facility. Sludge and liners from the PSP would also be removed. The closest licensed solid waste landfill is the U.S. Ecology landfill approximately 175 miles north of the MSM site. Total mileage per round trip haul would be 350 miles. Twenty-two miles of each round trip haul would be on park roads, and 9 miles would be on the unpaved road from the Morning Star Mine Road to the site. Solution evaporation or treatment measures would be instituted prior to removal activities until maximum evaporation levels had been achieved. Initiation of the Interim Measures in July 2002 has reduced the inventory of solution in Pad No. 2 to approximately 5,050,000 gallons. Enhanced evaporation measures would be continued until the volume of solution was reduced to a practical minimum. Removal of additional contaminated soils from areas adjacent to or under the pads and PSP may be necessary to ensure complete removal.

Berm materials around the PSP and the leach pads may have been contaminated by pad materials and process solution. Post-removal sampling would determine whether the berms would also be hauled as part of the material transported off site. The areas of the pads and PSP would be regraded to blend with the existing topography in a manner to minimize wind and surface water erosion. Six inches of suitable cover material would be applied and the site seeded. The suitable cover material would be obtained from the MSM site. Physical access routes would be kept in place until complete site closure has taken place.

A potential alternative to landfill disposal would be removal of heap leach pad material for an off-site beneficial use, such as aggregate for roadwork. Economic factors, including the haul distance to a construction site, would require its use to be in close proximity to MSM. Specific costs for this option to Alternative 4 have not been developed because no nearby roadwork is known to be scheduled (excessive haul distances would prohibit this alternative from being economically feasible). Should the opportunity for nearby roadwork present itself, the work would include installation of temporary tortoise fencing, detoxification of the heap leach pads, upgrading the unpaved road from the site to the Morning Star Mine road, and reclamation of the disturbance footprints of the heap leach pads, PSP, and access road.

10.4.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide a means of reducing the threat of direct contact with cyanide-bearing solution as well as the threat of cyanide coming into contact with groundwater as the result of loss of liner integrity or solution containment. Following maximum drawdown and evaporation of solution, the contents of the pads and PSP would be hauled to a licensed solid waste landfill. Environmental and ecological exposures would be eliminated on site upon completion of hauling the material. While there is some risk to human health and the environment posed by the loading and hauling operations themselves, this is not anticipated to be a significant risk. Standard construction practices will address human health and environmental safety during loading and hauling.

Of some considerable concern is the potential danger to park visitors represented by the additional truck traffic on park roads and the impact to the roadway itself. The road network in the park was not constructed in anticipation of the level of use reflected by this alternative. Pavement conditions are likely to deteriorate and the potential for accidents increase. Additionally, mapped tortoise habitat extends on both sides of the Kelso-Cima Road from south of the Kelso Dunes to State Highway 164 at Nipton and the I-15 interchange (NPS, 2002). Temporary fences could be installed to prevent the entry of desert tortoises into the process plant and loading area as well as the haul route to the Morning Star Mine road; however, the potential for tortoise mortality due to collision with vehicles will increase.

Off-Site Removal (Landfill) Haul Information

Total Material to Haul (two heap leach pads)	2,000,000 tons [1]
Trucks on Haul	40 trucks with pups [2]
Trips per day per truck	1.5 [3]
Length of Haul	350 miles round trip
Duration of Haul	3.2 years [4]
Total Road Miles for Project	17,493,000 road miles
Road Miles within Park Boundary	32 miles per round trip
Total Road Miles within Park Boundary	1,599,360 road miles

[1] Includes estimate of additional excavation from beneath pads (post-removal sampling over-excavation).
[2] Estimate based on haul truck with pup, 40 tons per load.
[3] Trip duration based on truck park in Las Vegas that will contain empty or full trucks, depending on direction of travel on given day.
[4] 833 days to haul at 260 working days per year.

10.4.2 Compliance with ARARs

The contents of the heap leach pads and PSP were derived from the beneficiation and extraction of ores and may be exempt from federal government regulation through RCRA as hazardous waste. Costs were developed using road legal equipment because this alternative presents hauling material off site. The state of California Department of Transportation limits road legal weights to 80,000 pounds. There is no cumulative limit on the number of vehicles or the number of trips as long as the weight of the truck and loads do not exceed that limit. Use of roads administered by the NPS requires registration with the Regional Director (36 CFR Ch. I, Part 9.15). If any damage to the road results, the operator will be liable for all damages. The state of California load limits do not restrict cumulative use. Damage to roads resulting from cumulative use within the boundaries of the Preserve is quite possible, given the number of haul trips that would be required by this alternative, the construction methods used for roads in the preserve, and desert heat.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during construction, hauling and regrading.

The project area is in the Ivanpah Desert Wildlife Management Area of the Eastern Mojave Recovery Unit as described by the Desert Tortoise Recovery Plan developed by the U.S. Fish and Wildlife Service (FWS, 1994). Location-specific ARARs may cause scheduling delays due to measures that may be required for protection of listed species. For example, worker awareness training and regular site and road patrols may be initiated to prevent harm to desert tortoises that may obstruct roadways (Desert Tortoise Council, 1999). It is anticipated that the mitigation measures developed for off-site removal of heap leach pad material will include the installation of temporary tortoise fencing, worker and driver education and safety precautions for haul trucks. All physical contact with tortoises would be restricted to authorized biologists. It is anticipated that a notification and abatement procedure would be required to physically remove individual tortoises from the project area or transportation route.

10.4.3 Long-term Effectiveness and Permanence

Under the off-site disposal alternative, the potential risk to human health and the environment from the heap leach pads and the PSP would be eliminated at the Morning Star Mine site. The solution inventory would be reduced through implementation of pumping and evaporative efforts

until the hauling of waste off-site could be started. The potential risk to human health from loading and hauling the heap leach pad material is considered to be minimal. Site grading and revegetation would re-establish vegetative cover and reduce erosion. Plant species would be selected for desert conditions and wildlife habitat.

10.4.4 Reduction of Toxicity, Mobility or Volume through Treatment

Hauling the solid waste from the heap leach pads and PSP to a licensed solid waste landfill would remove any potentially contaminated materials from the Morning Star Mine site for permanent disposal in an engineered facility. No potentially contaminated materials would remain within the heap leach pads or the PSP.

10.4.5 Short-term Effectiveness

Application of pumping and evaporative measures would greatly reduce the risk to human health and the environment from the potential loss of solution, increasing the short-term effectiveness of this alternative. Once solution volumes were reduced, which may require two or more seasons, it is anticipated that the haulage phase of this alternative would require over three 3.2years to complete. Haul times were calculated from the site to the U.S. Ecology facility using a fleet of 40 trucks (similar to the 4EM work plan) averaging 1.5 loads per day. Impacts associated with transportation of the heap leach pad material could be significant-.

Efforts to reduce the short-term impacts will be initiated during the construction phase prior to the start up of material hauling. Park ecologists will be consulted to develop plans for implementation of the alternative while providing maximum protection to park resources (Desert Tortoise Council, 1999). On-site workers would be protected by using industry standard personal protective equipment and by following proper operating and safety procedures. Impacts to air quality in the surrounding environment may occur from exhaust and road generated dust due to the relatively large number of trucks hauling the material to the landfill. The application of water or a dust suppressant as needed would provide control of fugitive dust emissions to sites receiving heavy vehicular traffic or in construction areas. Visitors to the Preserve and other users of the road network in the vicinity of the mine site may notice an increase in large truck traffic. Increased vehicular traffic and associated safety hazards, increased potential for tortoise mortality and dust generation will likely continue throughout the haulage phase of this alternative.

10.4.6 Implementability

This alternative is both technically and administratively feasible. Once the volume of solution has been reduced, material removal would be implemented. However, pumping down and evaporating the solution in Pad No.2 could take two or more years. The excavation, loading and hauling of pad and PSP material offsite, and the regrading and revegetating of disturbed surfaces will require construction methods and equipment that are readily available. Also, design methods and requirements are well documented and broadly understood.

Components or factors that could significantly prolong the implementation of this alternative as planned include: 1) restrictions to vehicular traffic (timing, volume, intensity) in response to environmental or community concerns; 2) controlling dust emissions during both excavation/hauling and reclamation phases of the operation; 3) difficulties encountered reducing the volume of solution in Pad No.2 or achieving target analyte levels; and 4) failure to identify a licensed solid waste landfill with the capacity adequate to accept the volume of material to be excavated from the site. Although U.S. Ecology has been identified for the purpose of this document, it is possible that at some future date this facility may not be available for this use.

10.4.7 Costs

Costs to implement the Off-site Removal Alternative include installation of temporary tortoise fencing, solution inventory reduction, removal of pad material, and site revegetation. Preliminary costs include installation of a bioremediation cell in the PSP to reduce the high levels of nitrates present in the solution. It is anticipated that temporary fencing would be installed from the site to the Morning Star Mine Road to protect the desert tortoise.

The total present worth cost for the Off-site Removal - Landfill Alternative has been estimated at $150,421,016. Costs to implement off-site removal are presented in Table 10.4 (Tables Section of Appendices).

Specific costs and potential revenues for the beneficial re-use option to Alternative 4 (aggregate) have not been developed because no nearby roadwork or other projects requiring aggregate are known to be scheduled (excessive haul distances would prohibit this alternative from being economically feasible).

10.5 Alternative 5 – Off-site Removal - The 4EM Company Work Plan

The 4EM Company proposes to reuse materials contained in heap leach pads No. 1 and No. 2 as pozzlan, a concrete additive. Pozzlan can be used to replace a portion of the Portland cement component of concrete. Its economic value is that it costs less than Portland cement (4EM, 2001). The 4EM work plan states that pozzlan will beneficially affect cement mixtures with:

- Increased strength;
- Increased sulfate resistance;
- Reduced temperature rise;
- Reduced expansion caused by alkali-silica reaction;
- Increased freezing and thawing resistance; and
- Reduced permeability.

To process the leach pad material, an on-site plant consisting of a ball mill would be constructed. The plant would be initially designed to crush and process up to 80 tons of material per hour, averaging up to 800 tons of material per day. During the second year of operation, a second ball mill would be added, increasing crushing capacity to 1,600 tons per day. Rubber tired loaders would be used to transport the heap leach pad material to the on-site processing plant, removing material from the top of the pads downward, to provide protection to the pad liners and leachate collection system during loading (4EM, 2001).

Heap leach pad material would be crushed to the desired particle size, and moved through an air separator and into a 1,500-ton storage silo. Reject material would be recycled back to the ball mill. The entire crushing operation would be constructed to be an enclosed system with a bag house designed to meet the requirements of the Mojave Desert Air Quality Management District (4EM, 2001).

The finished product would be transferred from the storage silo to a smaller, 250 ton silo used to load 25-ton pneumatic trucks. The loading spout would be equipped with a vacuum system to catch dust during the loading process. This dust would be recycled to the loading silo (4EM, 2001).

Power would be supplied by two 1,200 kW Caterpillar diesel power plants with noise suppression equipment to reduce noise levels to less than 75 dB. On-site fuel storage would consist of four 10,000 gallon above ground storage tanks sited on secondary containment systems. It is anticipated that two diesel fuel deliveries would be required monthly (4EM, 2001).

Other on-site support equipment and facilities include a 500-gallon waste oil tank, 40 cubic yard solid waste storage bin, and a 1,000 gallon sanitary waste tank. Two ½ ton pickups and a 15 - passenger van would be used on site and to transport employees. A 10 by 80-foot portable building would be used for employee dry and lunchrooms. The operator would occasionally require the use of heavy construction equipment such as a bulldozer, motor grader, and backhoe or loader. This equipment would be hired on an as-needed basis (4EM, 2001).

4EM proposes to use a portion of Pad No. 1 material for road base. Once road improvements are complete, roads will be maintained using dilute magnesium sulfate for dust control and blading to maintain the road surface. The crushing plant would operate 10 hours per day, five days per week. Trucks would be loaded 10 hours per day during the week and on a reduced schedule on weekends. 4EM proposes to use the off-site well and water pipeline for a water supply. A 4 kW generator will provide the power for the well. The applicant estimates that initial plant construction will require 180 days and plant start up 45 days. The plant operation would be 8 years.

Constructing a spray evaporation system on top of the pad would control seepage from Pad No. 2. A pump would be installed in the existing 24-inch sump in the pad, and leachate pumped to a series of spray nozzles on top of the pad. 4EM anticipates that 50 inches of water could be evaporated annually, reducing the level of leachate within the pad by 9.3 feet during the first year of operation. A work plan and preliminary engineering design will be negotiated with the MNP and LRWQCB to address the existing compliance orders (4EM, 2001). Immediate erosion control on Pad No. 2 would be controlled by strategic placement of rock, followed by an engineering evaluation to assess long-term alternatives.

Leachate detoxification would be initiated once the storage capacity of two year's precipitation volume within Pad No. 2 had been achieved through evaporation. Either microbiologic or chemical oxidation (sodium or calcium hypochlorite) methods would be used. Once

detoxification has been initiated, the spray evaporation system will be replaced by a drip irrigation system to conserve water.

A construction cost to complete the activities described in the 4EM work plan has not been submitted to MNP. The activities include site and road preparation, draw down and evaporation of solution in heap leach pad No. 2, crushing, loading and hauling pad material for use as pozzlan, and reclamation of heap leach pad and PSP areas. 4EM anticipates that $1,000,000 will be generated from the sale of pozzlan for use by the MNP.

10.5.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide a means of reducing the threat of direct contact with cyanide-bearing solution as well as the threat of cyanide coming into contact with groundwater as the result of loss of liner integrity or solution containment. The solution inventory would be reduced as much as possible through evaporative measures. Detoxification of cyanide would be achieved through application of microbiological technology or an oxidizing chemical.

Regrading and placement of 12 inches of base material would improve the Morning Star Mine Road for the proposed operation. 4EM plans to use a portion of Pad No. 1 material as the source of crushed rock for road improvements. Following maximum drawdown and evaporation of solution, the contents of the pads would be crushed to a fine powder and hauled from the site. While there is some risk to human health and the environment posed by the loading and hauling operations themselves, this is not anticipated to be a significant risk. Compliance with standard construction practices will address human health and environmental safety during loading and hauling. 4EM has committed to developing protocols and procedures for sampling and analysis of the pad material for cyanide.

Fine material may be found in the bottom of both pads. Fines do not de-water easily and may require additional effort to dry prior to processing via the feed hopper, conveyor, and ball mill. Additionally, this material may have elevated levels of some metals as well as cyanide and nitrates. 4EM will have to verify the absence of risk to human health and the environment for constituents of concern other than cyanide as the pozzlan product is marketed, sold and utilized.

Another concern is the potential danger to park visitors represented by the additional truck traffic on park roads and the impact to the roadway itself. The road network in the park was not constructed to handle the level of use reflected by this alternative. Pavement conditions are likely to deteriorate and the potential for accidents increase.

Mapped tortoise habitat extends on both sides of the Kelso-Cima Road from south of the Kelso Dunes to State Highway 164 at Nipton and the I-15 interchange (NPS, 2002). Temporary fences could be installed to prevent the entry of desert tortoises into the process plant and loading area as well as the haul route to the Morning Star Mine road. The implementation of the 4EM work plan would expose desert tortoises to a fairly high degree of human activity from project initiation to closure.

Duration and mileage for hauling the finished product have been computed to illustrate the potential volume of traffic on MNP roads.

Off-Site Removal (4EM) Haul Information

Total Material to Haul (two heap leach pads)	1,980,000 tons [1]
Trucks on Haul	Varies (10 – 40 per day)[2]
Trips per day per truck	Varies [3]
Length of Haul	Varies [3]
Duration of Haul	8 years
Total Road Miles for Project	Varies [3]
Road Miles within Park Boundary	32 miles per round trip
Total Road Miles within Park Boundary	2,534,000 road miles [4]

[1] Some heap leach pad material to be used for road repair
[2] Twenty-five ton pneumatic trucks. Estimate does not include plant construction phase traffic (4 months), additional operational phase traffic (8 years - includes two tankers per month for power generator fuel), plant expansion phase traffic (2 months), or closure phase traffic (3 months).
[3] Trucks will haul to Las Vegas or Los Angeles. This alternative will have truck volumes similar to the off-site (landfill) alternative.
[4] It will require approximately 80,000 truckloads over the 8 year time frame (80,000 trips * 32 miles per trip). The off-site haul (landfill option) has fewer miles; however, that option includes trucks utilizing pup trailers.

Once the product transportation phase has been completed, reclamation of the disturbance footprints of the pads and the PSP would be initiated. The work plan preliminary project schedule spans a 10-year period.

10.5.2 Compliance with ARARs

There is some uncertainty regarding the regulatory framework for remediation of this site. The site does not meet typical definitions of an abandoned site: there is still an operating entity present with valid mining claims. Although the operating permit and bond no longer exist, the Vanderbilt entity still is present.

Abatement orders have been served to Vanderbilt and the MNP regarding the discharge of wastes from the pads (refer to the Cleanup and Abatement Orders in the appendices). Extensive characterization and monitoring activities have been drafted that the NPS was planning to perform with liability imposed on Vanderbilt Gold.

At the state level, Regional Water Quality Control Boards regulate water quality and waste discharge requirements. The MSM site is within the jurisdiction of the LRWQCB. The LRWQCB will participate in the decision-making process to identify the preferred alternative for remediation of the site and impose discharge requirements for closure. Surface reclamation of mines is regulated at the county level in California. Under CERCLA regulations, the requirements of the Surface Mining and Reclamation Act administered by San Bernadino County would be relevant and appropriate for consideration in the development of the closure plan for the site.

The 4EM work plan reflects the belief that Pad No. 1 has been detoxified. No regulatory agency has verified the detoxification measures. NPS personnel have no knowledge of the drilling or sampling methods used. The solution from the two pads has now been co-mingled. The solution from the pregnant solution pond was pumped to the top of Pad 1 in May 2002 and again in July 2002Removal of material that has not been detoxified would not comply with the LRWQCB WDRs. Hauling the finished product will require compliance with MNP, San Bernadino County and California highway regulations regarding use of roads in the MNP, load limitations and use of public roadways.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during construction, hauling and regrading. The project area is in the Ivanpah Desert Wildlife Management Area of the Eastern Mojave Recovery Unit as described by the Desert Tortoise Recovery Plan developed by the U.S. Fish and Wildlife

Service (FWS, 1994). Worker awareness training and regular site and road patrols may be initiated to prevent harm to desert tortoises that may obstruct roadways (Desert Tortoise Council, 1999). It is anticipated that the mitigation measures developed for the 4EM work plan will include worker and driver education and safety precautions for haul trucks. All physical contact with tortoises is restricted to authorized biologists. It is anticipated that a notification and abatement procedure would be required to physically remove individual tortoises from the work area or transportation route.

10.5.3 Long-term Effectiveness and Permanence

The potential risk to human health from loading and hauling the heap leach pad material is considered to be minimal once detoxification has taken place; however, additional detail is needed to evaluate the work plan's long-term effectiveness. Site grading and revegetation would re-establish vegetative cover and reduce erosion. Plant species would be selected for desert conditions and wildlife habitat.

10.5.4 Reduction of Toxicity, Mobility or Volume through Treatment

The 4EM work plan describes development of a sampling and analysis program to verify detoxification of Pad No. 1 and detoxification of Pad No. 2 through microbiologic or chemical oxidation. The detoxification procedures described reflect industry standards for oxidation of cyanide; however, recent findings concerning the elevated levels of nitrates will have to be addressed. The work plan also refers to the pad material as a beneficiation mining waste, which would exempt the operator from hazardous waste regulations. While this exemption could generally be applied to the waste rock dumps, the heap leach pads and solution in the PSP have had specific waste discharge requirements developed by the LRWQCB.

10.5.5 Short-term Effectiveness

Application of pumping and evaporative measures would greatly reduce the risk to human health and the environment from the potential loss of solution, increasing the short-term effectiveness of this alternative. Once solution volumes were reduced, which may require two or more seasons, it is anticipated that the processing and hauling phases of this alternative would require eight years to complete. Impacts associated with transportation of the heap leach pad material could be significant.

4EM has described measures to reduce the short-term impacts that would be initiated during project start up, specifically, the upgrading of the road to the site from the Morning Star Mine Road. Park ecologists would be consulted to develop plans for implementation of the alternative while providing maximum protection to park resources. However, it is not clear how compliance with the WDRs will be achieved prior to the potential exposure of on-site workers, truck drivers and individuals who purchase and use the final product or the impact of its use as a construction material. Additionally, potential impacts to the tortoise population could occur as soon as the volume of traffic is increased.

Impacts to air quality in the surrounding environment may occur from exhaust and road generated dust due to the relatively large number of trucks hauling the material to either Las Vegas or Los Angeles. The application of water or a dust suppressant as needed would provide control of fugitive dust emissions to sites receiving heavy vehicular traffic or in construction areas. Visitors to the Preserve and other users of the road network in the vicinity of the mine site will probably notice an increase in large truck traffic. Increased vehicular traffic, and associated safety hazards, increased potential for tortoise mortality and dust generation will likely continue as impacts throughout all phases of this alternative.

10.5.6 Implementability

Once regulatory questions have been answered regarding the characterization and ability to "discharge" pad material and solution off containment, this alternative becomes technically feasible. When the volume of solution and heap leach pad material have been reduced to the required compliance levels processing of the pad material into pozzlan could begin. However, pumping down and evaporating the solution in Pad No.2 could take two or more years. The excavation, crushing and hauling of the finished product offsite, and the regrading and revegetating of disturbed surfaces will require construction methods and equipment that are readily available. Also, design methods and requirements are well documented and broadly understood.

Regulatory issues or factors that could significantly prolong the implementation of this alternative as planned include:

1) negotiating discharge levels with the LRWQCB;

2) negotiating restrictions to vehicular traffic (timing, volume, intensity) in response to environmental, agency or community concerns;
3) controlling fugitive dust emissions during both excavation/processing/ hauling and reclamation phases of the operation;
4) potential difficulties encountered reducing the volume of solution in Pad No.2 or achieving target analyte levels for detoxification and off-site transport; and
5) market variables influencing the sale of the finished product. Issues related to liability and responsibility for specific actions will need to be negotiated among the parties.

4EM proposes to control the final volumes of leachate and draindown from the pads to the PSP through evaporation. Closure of the PSP would consist of removal and off-site disposal of any solids, leachate, liner and leak detection system.

10.5.7 Costs

A construction cost to complete the activities described in the 4EM work plan has not been submitted to MNP. The activities include site and road preparation, draw down and evaporation of solution in heap leach pad No. 2, crushing, loading and hauling pad material for use as pozzlan, and reclamation of heap leach pad and PSP areas. 4EM anticipates that $1,000,000 will be generated from the sale of pozzlan for use by the MNP.

Some costs from other alternatives presented in this document could reasonably be similar; solution inventory reduction via evaporation, establishing stormwater controls, temporary tortoise fencing and site revegetation.

4EM proposes to detoxify the heap leach pads through microbiologic techniques or the use of chemical oxidants such as sodium or calcium hypochlorite. The cost to achieve regulatory discharge requirements will be determined by the chemical nature of the pad material and solution, the method used for detoxification, the timeframe and budget of the applicant, and the cost for the delivery system itself.